INSTRUCTION MANUAL

MODEL DL40-1

SILICON DUAL LAB SERIES

TRANSISTORIZED POWER SUPPLY

TRYGON ELECTRONICS
SUBSIDIARY
SYSTRON DONNER
CORPORATION

1200 SHAMES DRIVE • WESTBURY, N.Y. 11590

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NOTICE

This Instruction Manual provides general characteristics, operating procedures, theory of operation and includes a complete schematic and if available, a parts list for the the model (s) listed on the front cover.

Any questions concerning this documentation should be directed to the Publications Dept., Trygon Electronics, Inc., Roosevelt, N.Y., 11575.

Questions concerning the operation and application of Trygon power supplies should be directed to the Applications Engineering Dept., at the above address.

MEASUREMENT OF REGULATION AND RIPPLE

The specifications cited herein for regulation and ripple can be readily attained on every Trygon power supply, provided the proper method of measurement is employed. The major consideration is that the highly stable meter and oscilloscope, specified in the calibration section test procedures, must be connected to the sensing terminals and not at the load terminals. The reason for this voltage drop between the load terminals and sensing terminals will yield in an inaccurate regulation and ripple measurement.

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List of Electrical Parts
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SECTION 1
DESCRIPTION

1.1 INTRODUCTION

The Silicon Dual Lab Series power supply is a flexible and dependable source of DC power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes this unit well suited for use as basic laboratory power sources. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems requirements.

The versatility of this unit is enhanced by the enclosure of two identical but independently adjustable power supplies in a common package.

All components used in the construction of the Silicon Dual Lab Series units are of the highest quality available, and have been subjected to 100% incoming inspection.

Each electrolytic filter capacitor is of computer grade, and has been quoted by the manufacturer as having a life expectancy exceeding ten (10) years. All silicon transistors have been "derated" and temperature aged to provide high reliability. All rectifiers are hermetically sealed silicon units, and all zener diodes have been temperature stabilized.

1.2 GENERAL FEATURES

Output, Sensing and Remote Programming terminals are located on two eight terminal barrier strips mounted on the rear panel of the unit. The AC power switch, AC pilot lamp, coarse and fine voltage controls, current limit/voltage range selector and appropriate metering devices are all located on the front panel. For convenience, additional output terminals have been provided on the front panel.

Constant Voltage Mode

A constant voltage is maintained across the output terminals within the rated voltage output, provided that the load does not draw more than the rated output current.

Short Circuit Protection

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. In the event of a short circuit, the output voltage will return to its previous level only upon removal of the short circuit.

The point at which current limiting occurs is adjustable by the front panel Current Limit/Voltage Range select switch.

Current Limit/Voltage Range Selector

Two front panel rotary selector switches (identical) provide a means of selecting different current limit values for the two output voltage ranges. The switch provides 2 current limit values in the 0-20v range and 4 values in the 0-40v range. In the 0-20v range, the output is adjustable from 0 to 20 volts and the current limit values can be set at either .75A or 1 amp. In the 0-40v range, the output voltage is adjustable from 0-40v and the current can be limited to .05, .10, .25 or .50 amps, depending on the switch setting.

Remote Programming

Remote Programming is provided in the voltage mode of operation, and may be utilized over the entire voltage range of the unit. The scale factor for Remote Voltage Programming is 1000 ohms per volt.

1.3 PRECAUTIONARY MEASURES

Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from underrated or overloaded AC input lines. The maximum AC impedance from the breaker box to the power supply input should not exceed 0.75 ohms.

Voltage Regulator and Inverter Inputs

Care should be used when using voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the power supply, may cause serious loss of regulation of the power supply output. Capacitive input filtering used for semiconductor power supplies requires charging to the peak of the rectified AC wave which non-sinusoidal AC sources may not provide.

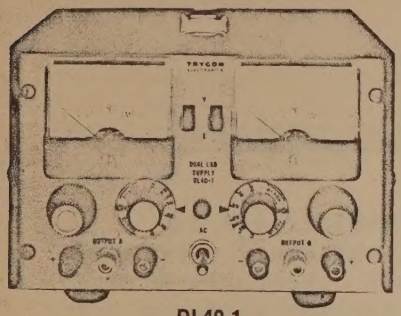
Systems Considerations

In systems applications it is recommended that each power supply input power line be run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. Do not run sensitive signal leads such as the remote sensing leads in the same cable as the AC input without shielding. To keep the AC ripple in the output to a minimum, it is recommended that the AC input cables should not be run in close proximity to the output load cables.

Terminal Post Resistance

All terminals and shorting links serving Outputs, Sensing and Programming must be securely tightened before use. Serious loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links.

DL40-1 Dual Output Lab Series



DL40-1

Features

- Dual Outputs — Independently Adjustable
- Dual Ranges on Each Output
- Calibrated Adjustable Current Limiting
- Remote Voltage Programming
- Remote Sensing
- Series or Parallel Operation
- No Turn On/Turn Off Transients

Description

The Trygon DL40-1 Silicon Dual Lab power supply is a dual-output, dual-range unit designed for general laboratory applications. It consists of two separate internal power generating sections, each adjustable in voltage and with separate outputs on the front panel and rear barrier strip.

A variety of voltage and current outputs are available providing unexcelled operational versatility and flexibility. This output flexibility permits the user to have complete convenience in filling laboratory power supply requirements.

The Dual Lab power supply utilizes silicon semiconductors permitting operation at its maximum temperature rating without derating.

	Output		
Model	Volts	Amps	*Impedance DC-1 kHz
DL40-1	Dual 0-20	0-1	0.002
	0-20	0-2 (Parallel)	
	Dual 0-40	0-.5	
	0-40	0-1 (Parallel)	
	0-80	0-.5 (Series)	

*Nominal

This model is priced at $249.

Electrical Specifications

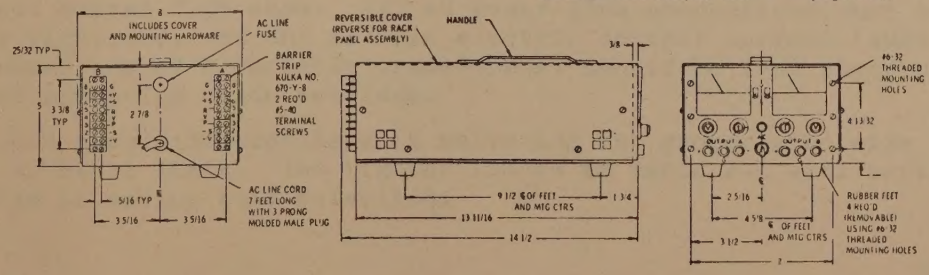
Input:	100-125/200-250 VAC, 47-420 Hz. (Internal Tap Change).
Output:	Dual, Floating; isolated from ground, 300 VDC max.
Regulation, Line:	0.01% or 2 mV*, for 100-125/200-250 VAC line change, at any output within specifications.
Regulation, Load:	0.01% or 3 mV*, no load to full load, at any output within specifications.
Ripple:	250 μV RMS, 2 mV p-p. (10 MHz) (20 mV p-p @ 420 Hz Input.)
Stability:	0.05% or 10 mV*, for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient:	(0.02% + 400 μV)/°C.
Temperature Range:	0 to + 50°C.
Recovery Time:	25 microseconds to within 0.05% or 15 mV* of output voltage, for 100% step change in rated load.
Short Circuit Protection:	Automatic Calibrated Current Limiting.
AC Power Input Protection:	Fuse.
Remote Voltage Programming:	Over output voltage range. Scale factor approximately 1000 Ohms/volt.
Remote Sensing:	Maintains rated regulation directly at the load. Maximum line drop 0.5 volts per leg.
Voltage Adjustment Range:	Continuously adjustable, concentric vernier controls.

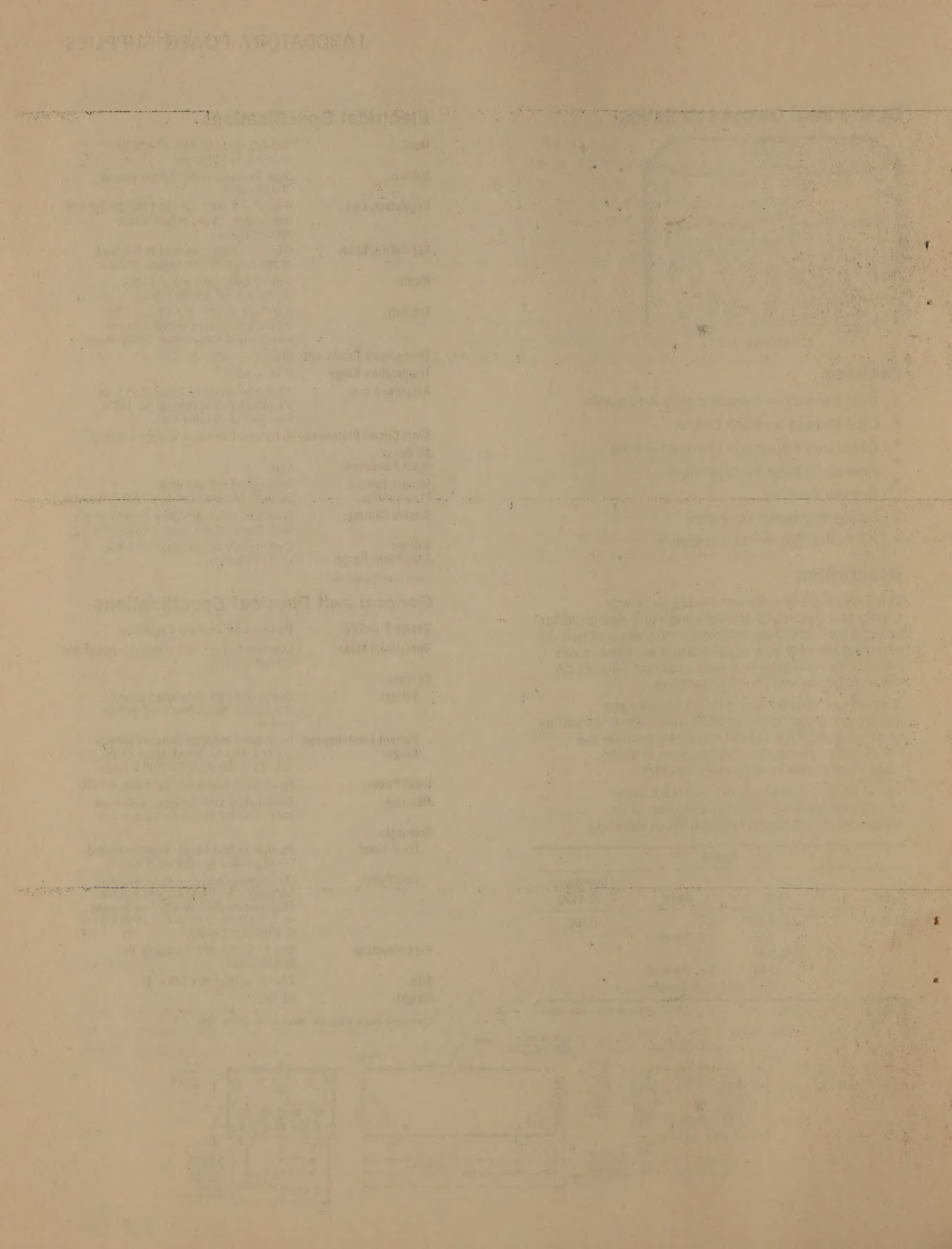
*Whichever is greater.

General and Physical Specifications

Design Principle:	Precision Series Pass Regulation.
Operational Mode:	Constant Voltage with automatic adjustable current limiting.
Controls:	
Voltage:	Coarse and Fine; 0 to rated output; front panel. Resolution 1 mV on fine control.
Current Limit/Voltage Range:	Front panel selector switches provide .75 or 1 amp for 0-20 V range or .05, .10, .25 or .50 amps for 0-40 V range.
Input Power:	Front panel switch and indicator, AC ON.
Metering:	Combination Volt/Ammeter with front panel selector switch for each supply.
Terminals:	
Front Panel:	Positive Output (+ V); Negative Output (— V); Ground (G). (For each supply).
Rear Panel:	(1) Negative Output — V; (2) Negative Sensing — S; (3-4-5) Remote Voltage Programming RVP; (6) Positive Sensing + S; (7) Positive Output + V; (8) Ground G. (For Each Supply).
Rack Mounting:	RPA-1 (single), RPA-2 (mounts two DL40-1 units).
Size:	7¾" W x 4 5/16" H x 14½" D
Weight:	17 lbs.

Detailed rack adapter data is on page 106.


INCLUDES COVER AND MOUNTING HARDWARE
AC LINE FUSE
25/32 TYP
BARRIER STRIP KULKA NO. 670-Y-8 2 REQ'D #6-40 TERMINAL SCREWS
AC LINE CORD 7 FEET LONG WITH 3 PRONG MOLDED MALE PLUG
REVERSIBLE COVER (REVERSE FOR RACK PANEL ASSEMBLY)
HANDLE
9 1/2 C OF FEET AND MTG CTRS
13 11/16
14 1/2
#6-32 THREADED MOUNTING HOLES
RUBBER FEET 4 REQ'D (REMOVABLE) USING #6-32 THREADED MOUNTING HOLES
6 OF FEET AND MTG CTRS



SECTION 2

INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

General

If the Silicon Dual Lab series power supply is to be used in a portable bench type configuration, no special mechanical installation is required. However, if the unit is to be rack mounted, special rack mounting adapters must be used to secure the unit to the relay racks. Single (RPA-1) and dual (RPA-2) rack panel adapters are available.

Rack Panel Adapter Mounting

1) Remove the 6-32 screws which fasten the cover to the power supply chassis.

2) Remove and rotate the cover so that the front is now facing to the rear.

3) Fasten the cover securely in position with the 6-32 screws previously removed.

4) Attach the handles to the Rack Panel Adapter.

5) Stand the Rack Panel Adapter in front of the power supply. In order to mount the power supply properly, the top of the Rack Panel Adapter must face up. The top is distinguishable from the bottom in that all the holes, including those for the handles, are in a straight row across the front of the Rack Panel Adapter.

6) Attach the power supply to the Rack Panel Adapter with the 6-32 screws and lock washers provided.

2.2 ELECTRICAL CONNECTIONS

Input, Power:

A heavy duty 3 wire line cord and molded plug with grounding prong provides a path for input power to the unit.

The power handling ability of the AC power lines feeding AC power to the line cord must be considered, as serious losses in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. The AC impedance from the breaker box to the power supply input connector should not exceed 0.75 ohms. All AC power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The figures listed in Table 2-1 will serve as a guide in making this selection.

TABLE 2-1 - AC INPUT WIRE SIZE

Length of Run (Single Lead)	Wire Size (AWG Standards)
10 feet or less	12
10 feet to 20 feet	10
20 feet to 50 feet	8
50 feet to 100 feet	6

Output, Rear Panel

Two eight (8) terminal barrier strips mounted on the rear panel provide independent output, sensing, programming and ground connections for both sections of the unit. TABLE 2-2 SHORTING LINK APPLICATION, lists the required shorting link connections for the various modes of operation.

Output, Front Panel

Two binding post terminal sets mounted on the front panel provide output and ground connections for both sections of the unit.

TABLE 2-2 - SHORTING LINK APPLICATION

Terminals	Condition	Function
1 and 2 6 and 7	Connected Connected	Local sensing and regulation at rear panel output terminals.
1 and 2 6 and 7	Not Connected Not Connected	Remote sensing and regulation at load. Run individual leads between terminals 2 and 6 and load.
4 and 5 4 and 3	Connected Not Connected	Local voltage programming. Output determined by setting of front panel voltage adjustment controls.
4 and 3 4 and 5	Connected Ext. PGM res.	Remote voltage programming. Output dependent upon setting of external remote programming resistor.

NOTE If terminals 1 and 2 or 6 and 7 are left open, the output will become unregulated.

Front or Rear Panel Output Selection

DC output terminals for both sections of the power supply are located on the front and rear panels of the unit. Sensing terminals, however, are available only at the rear panel barrier strips. If the load is connected to the front panel output terminals but sensing

connections are made from the rear, serious deterioration of regulation may occur. Therefore, front panel output terminals should be used primarily for output monitoring purposes.

Shorting Link Application, Rear Panel

The power supply is shipped from the factory with shorting links in place across terminals 1 and 2, 4 and 5 and 6 and 7 of the rear panel barrier strips. In this configuration, and with the load connected across the rear panel output terminals, local sensing and programming operation from the rear panel is provided. Connections for other rear panel modes of operation are shown in TABLE 2-2 SHORTING LINK APPLICATION.

2.3 CONTROLS

Front Panel

TABLE 2-3 FRONT PANEL CONTROLS

Name	Function
AC Power	Toggle switch, controls input power.
Meter Function A Meter Function B	Slide switch, selects output meter indication.
Voltage Adjust A Voltage Adjust B	Potentiometer, adjusts voltage output.
Voltage Vernier A Voltage Vernier B	Potentiometer, adjusts voltage output.
Current Limit/ Voltage Range Selector A Current Limit/ Voltage Range Selector B	Rotary switch, selects current limit values and output voltage range.

Internal

All internal control settings have been factory preset, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this instruction manual.

2.4 OPERATION

Connections

Prior to the application of power, connect all loads; external wiring and shorting links required for the mode of operation desired.

Grounding

Either side of the output may be grounded, or the output may be used in a floating condition.

Power On

Connect the line cord to a nominal AC input power source. Set POWER switch S1 to AC-ON, and observe that pilot lamp DS1 glows.

Warm-Up

No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommended to reach rated stability.

Series Operation

To operate both sections of this power supply in a series configuration, connect the output of each section in series. When operating in this mode, it is necessary to adjust the output of each section independently. The output voltage is equal to the sum of the voltage settings of each section.

Parallel Operation

Both sections of the Dual Lab power supply may be placed in parallel to provide a combined current capability twice that of a single section.

A) Before placing the sections in parallel, each section should be set to provide exactly the required voltage.

B) Set the step current limit adjustment on each supply to maximum position if maximum current capability is desired or to the nearest current limiting point in excess of 1/2 the rated current if a reduced current limit point is desired.

C) Connect the power supply sections in parallel as shown in Figure 2.

WARNING: Two supplies (sections) must not be placed in parallel if their voltage outputs are different by more than approximately two volts.

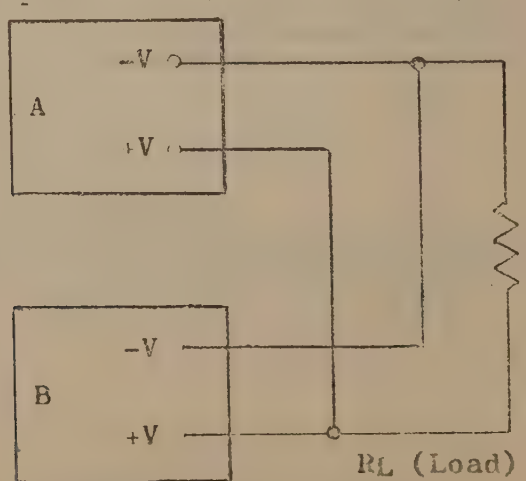


FIGURE 2

SECTION 3

THEORY OF OPERATION

3.1 GENERAL

The purpose of the Trygon Dual Lab Series power supply is to provide two fully independent, well regulated and adjustable DC outputs in a single compact and versatile half rack configuration. Both outputs may be used independently or in series or parallel combination with each other, thereby greatly increasing the output range capabilities of this unit.

The electrical circuitry of both operating sections of the unit is identical. To differentiate between the two operating sections, one section is designated as the "A" supply and the other as the "B" supply. In addition, all reference designations in the "B" section are prefixed by the number one hundred. Except for the use of prefix numbers in the "B" section, the component values for both operating sections are identical.

Therefore, the reference designations referred to in the following circuit descriptions may be applied to either operating section by adding the prefix number to the reference designation when applicable.

The following paragraphs describe the major circuits used in the DL40-1 power supply. As each circuit is described, reference should be made to both the Block Diagram, Figure 3-1 and the Schematic Diagram in the rear of this manual.

Primary Input

Input power is obtained through power transformer T1, full wave rectifier sets CR1 and CR2, CR10 through CR13, and filter capacitors C1 and C6.

When AC power switch S1 is set to AC ON, pilot lamp DS1 illuminates, and AC power is applied to transformer T1. DC output power is immediately available from both operating sections.

Front panel current limit/voltage range selector switch S2 determines the output voltage range and current limit values by changing input transformer taps and changing the resistance values in the current sensing circuit.

When switch S2 is set to the 20v/1A position, power transformer T1 and rectifier diode set CR12 and CR13 operate in a full wave center tapped configuration. In this configuration, the effective value of the secondary voltage across transformer taps 3 and 4 is developed across input capacitor C6. However, when switch S2 is set to the 40v/.50A position, power transformer T1 and rectifier diodes CR10 through CR13 operate in a full wave bridge rectifier configuration. When operating in this configuration, the effective voltage developed across input capacitor C6 is approximately twice the value previously developed across transformer taps 3 and 4.

Reference Supply

The rectified and filtered voltage from diode rectifiers CR1 and CR2 and filter capacitor C1 is preregulated by reference zener diode CR3. This stabilized DC voltage is supplied to constant current source Q1, whose output is in turn regulated by voltage reference zener diode CR5. The voltages developed across voltage reference zener diodes CR4 and CR5 are highly stable reference voltages established at a higher positive potential than the positive output of the power supply.

Series Regulator

The rectified DC voltage from the input diode rectifiers and input capacitor C6 is directed through series pass transistor Q8. Conduction of this transistor is controlled by circuitry which causes it to act as a variable resistor. Overall resistance of the series pass varies in accordance with the need of the power supply to increase or decrease its output voltage or current.

Conduction of Q8 is directly controlled by driver stages Q10 and Q9, which in turn are controlled by error amplifier Q5.

Comparator and Error Amplifier

Voltage sensing and comparison is accomplished by differential amplifier Q7. A sample of the output voltage on the base of Q7 is compared to the stable reference voltage at the base of Q6. An unbalance caused by a change in voltage at either negative sensing (-S) barrier strip terminal 2, or across voltage adjustment controls R42 and R43, will appear as a voltage change at the collector of Q7.

This difference voltage is amplified by error amplifier Q5, and is used to regulate series pass driver Q8 by means of driver stages Q10 and Q9. Error amplifier Q5 has two diode inputs to its base which form an "or" gate for error signals. CR7 presents error signals from differential amplifier Q6, which CR6 presents an error signal in the event of either a short circuit or when the power supply is driven into the current limiting mode of operation.

When operating in the current limiting mode, differential amplifiers Q2 and Q3 become balanced, thereby causing CR6 to conduct and in turn, drive error amplifier Q5 toward cut-off.

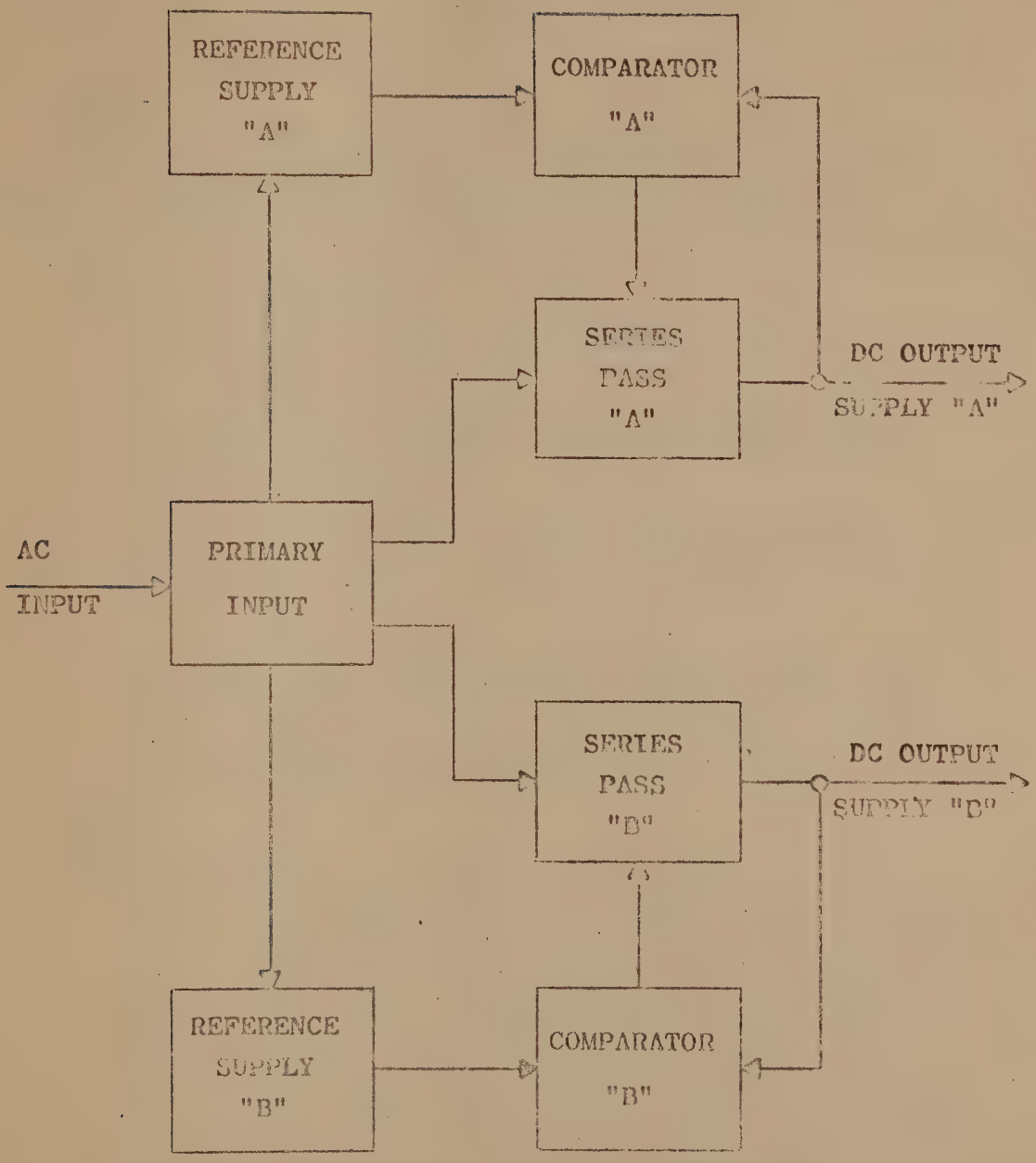


FIGURE 3-1 - BLOCK DIAGRAM

SECTION 4
MAINTENANCE

4.1 GENERAL

This power supply is a precision instrument. It is strongly recommended that only experienced troubleshooting personnel perform troubleshooting operations or attempt to repair the unit. If the power supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

4.2 LOADS AND INTERCONNECTIONS

1. Disconnect all interconnections and loads to which the unit is normally connected.
2. Place shorting links between rear panel barrier strip terminals 1 and 2, 4 and 5, and 6 and 7. These connections must be securely made, or deterioration of output regulation will occur.
3. Connect a resistive dummy load across output terminals 1 and 7. This load should be of sufficient value to allow the unit to operate at its maximum rated current and voltage output.
4. Apply nominal AC input power to the unit and check for normal operation. Satisfactory operation at this time would indicate that any malfunction previously encountered, is external in nature. All interconnections and loads normally used in conjunction with this power supply should then be carefully checked for electrical defects.

4.3 TROUBLESHOOTING

1. Set front panel range switch S2 to its 40V/.50A position, and voltage adjustment controls fully CW. Using a 20,000 ohms per volt voltmeter or oscilloscope, check the voltages across the various circuit components listed in the TROUBLESHOOTING GUIDE, located immediately before the schematic diagram at the rear of this instruction manual. The sample voltages listed in this guid apply only if the unit is operating at its nominal AC input, and has a dummy load of sufficient size connected across its output to allow operation at maximum rated current and voltage output levels. Any reading which is grossly incorrect indicates that the stage being tested or the one immediately preceding it, is defective. The Block Diagram, Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any troubleshooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2. If voltage checks show no noticeable deviations from the prescribed values, disconnect AC power and proceed with point-to-point resistance checks across pots, switches, diodes, resistors, transistors, in that order.

3. When the trouble is of an intermittent nature such as poor regulation, ripple, etc., the use of an oscilloscope to determine dynamic changes will be necessary. The section on Theory of Operation should be consulted to determine circuit performance with varying output conditions.

SECTION 5
CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the Trygon power supply.

5.2 TEST EQUIPMENT REQUIRED (or equivalent)

A) Oscilloscope, Tektronix Type 561

B) Differential Amplifier Plug In, Tektronix Type 63

C) Time Base Plug In, Tektronix Type 67

D) Differential VTVM, Fluke Model 825A

E) AC VTVM, Hewlett Packard Model 400D

F) VOM, Simpson Model 260

G) Variable Auto transformer, Powerstat Type 3PN136 (20 Ampere rating)

Shorting Link Application

For test purposes, shorting links should be connected across barrier strip terminals 1 and 2, 4 and 5, and 6 and 7 to provide local sensing and local voltage programming. To reduce pickup, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground loops, it is important that only one ground connection be made, as shown in Figure 5-1. Tighten all terminal connections as securely as possible, and set all front panels controls fully CW.

5.3 CALIBRATION PROCEDURE

Voltage Adjust Control

A) Maximum Voltage

Set front panel voltage adjust controls fully CW. Adjust Maximum Voltage control R20 to obtain an output voltage in excess of the rated output.

B) Minimum Voltage

Set front panel voltage adjust controls fully CCW. Adjust minimum voltage control R24 to obtain a negative output voltage of 0.1 VDC.

Ammeter Adjustment Control

Connect an external test ammeter of appropriate current handling capacity in series with a suitable load.

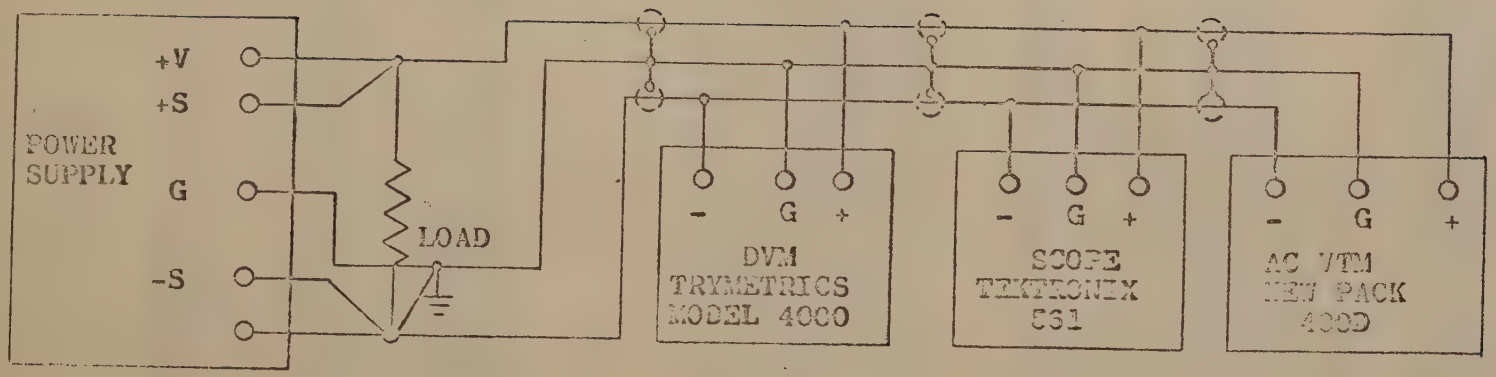


FIGURE 5-1
CONSTANT VOLTAGE OPERATION

Set front panel Meter Select switch S3 to its current monitoring position. Operate the unit at its rated output as indicated on the external test ammeter, and adjust Ammeter Adjustment control R39 until front panel meter M1 indicates a reading of the same value as that indicated by the external test ammeter.

Constant Voltage Operation

A) Load Regulation

With the equipment connected as shown in Figure 5-1, connect a suitable load resistance across the output terminal connections. The load resistance selected must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output. The maximum change in output DC voltage indicated on the Differential VTVM should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

B) Line Regulation

Place the resistive load across the output and note the voltage indicated on the Differential VTVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum change in output voltage should not exceed by more than 0.01% or 2mv (whichever is greater) that of the output voltage measured at either extreme of the AC input.

C) Ripple Voltage

In order to reduce pickup, shielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the AC VTVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum ripple amplitude should not exceed 250μv RMS.

Current Limiting

With the equipment turned off, connect a variable resistive load across output terminals 1 and 7. Set front panel meter switch S3 to its voltage (V) position. Set the variable load resistor to its maximum resistance setting, and then slowly decrease the resistance until a decrease in the voltage indication on front panel meter M1 occurs. Observe that as the resistance value continues to decrease, the indicated output voltage also decreases. Set front panel meter switch S3 to its current (I) position, and note the current indication. Current limiting is effective at the indicated level.

Semi-conductors commonly used in Trygon power supplies are available for replacement or spare parts use under the following Trygon, commercial manufacturer of JEDEC part number

TRANSISTORS

S E M I - C O N D U C T O R P A R T N U M B E R S

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUIVALENT
700000	TR1132	2N1132
700001	2N3638A	2N3638A
700010	TR346	2N1556
700020	TR360	2N360
700030	TR361	2N652
700040	TR375	2N1533
700047	2N4238	2N4238
700050	TR656	2N653
700060	TR890	
700070	TR951	2N2527
700071	TR1000	
700080	TR1490	2N3055
700083	TR1493	2N1490
700085	TR1495	2N3442
700110	TR2195	2N2195
700115	TR2905	2N2905
700130	2N1554	2N1554
700180	16B507	2N2712
700181	2N3566	2N3566
700191	TR1591	2N3054
700200	TR1512	2N2139
700205	TR1690	2N3440
700401	2N3771	2N3771
700402	2N3772	2N3772
700410	TR3442	2N3442
700411	2N3569	2N3569
700412	2N3568	2N3568
700418	2N4921	2N4921
700419	2N4410	2N4410
700429	DTS411	
700430	DTS413	
700431	DTS423	
700502	2N5037	2N5037
705018	2N2416	2N3416
705030	16J1	2N3605
705031	2N3691	2N3691
705045	NS1835	
705065	MCA1912N	
700072	F.D. 1329	
700413	2N3644	2N3644
700416	2N4355	2N4355
700417	2N4918	2N4918

TRANSISTOR & DIODE REPLACEMENT PARTS LIST

TRY. OLD STOCK #	TRY. or MFR. P/N	TRY. NEW STOCK #	TRY or MFR P/N
700045	TR496	700047	2N4238
700046	TR497	700047	2N4238
700075	1390S	700080	TR1490
700081	TR1491	700080	TR1490
700082	TR1492	700080	TR1490
700084	TR1494	700080	TR1490
700100	TR2148	700110	TR2195
700150	2N2138	700200	TR1512
700166	2N3142	700410	2N3442
700170	4JD5E25	720145	UJ25
700190	TR1590	700191	TR1591
700192	TR1592	700191	TR1591
700196	TR1594	700191	TR1591
700210	TR697	700110	TR2195
705000	TR652	700030	TR351
720040	C50B	720057	C50B OV
720050	C50F	720058	C50F OV
720070	E033	720381	1N4395
720077	G100B	720384	1N4384
720080	SG22	720384	1N4384
720090	SG1235	720384	1N4384
720140	1N2166	720262	1N2163A
720180	1N751	720181	1N751A
720189	1N752	720185	1N752A
720200	1N1341	720129	720129
720210	1N1342	720132	720132
720220	1N1343	720131	720131
720240	1N1345	720133	720133
720245	40110	720131	720131
720250	40114	720137	720137
720260	TR2620A	720263	Z0132
720261	TR2621A	720262	1N2163A
720323	10Z24T5	720241	1N1360A
720328	720328	720330	70H10
720380	SC2	720384	1N4384
720382	1N4383	720384	1N4384
725014	TR253	720129	720129

Semi-conductors commonly used in Trygon power supplies are available for replacement of spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

RECTIFIERS

SEMI-CONDUCTOR PART NUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUILVALENT
720055	TR83	
720057	C50B OV	
720058	C50F OV	
720060	E016	
720075	E0130	
720110	SV515	1N821
720129	720129	
720130	720130	
720137	720137	
720138	1N2624B	1N2624B
720139	1N2167	1N2167
720140	1N2166	1N2166
720145	UJ25	2N2647
720150	UZ715	
720151	UZ806	
720153	UZ820	
720155	UZ724	
720181	1N751A	1N751A
720182	1N754A	1N754A
720192	1N753B	1N753B
720196	1N755A	1N755A
720241	1N1360A	1N1360A
720262	1N2163A	1N2163A
720263	Z0132	
720273	SCR285-2	
720274	SCR285-3	
720275	SCR285-4	
720277	SCR285-5	
720290	SCR93-3	2N2573
720300	SCR93-4	2N2574
720301	SCR93-5	2N2677
720330	70H10	
720340	70H15	
720350	70H20	
720381	1N4385	1N4385
720384	1N4384	1N4384
720390	SSD708	
720397	1N2165A	1N2165A
720148	UZ712	
720394	1N964B	1N964B
720395	1N965A	1N965A
720440	TR4148	1N4148
720454	MR1031A	
720455	MR1032A	
720456	MR1034A	
720457	MR1035A	
720459	1N758	1N758
720466	1N983A	1N983A
720468	1N968	1N968
725016	1N702	1N702

ELECTRONICS INC.

Semi-conductors commonly used in Trygon power supplies are available for replacement or spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

RECTIFIERS

SEMI-CONDUCTOR PART NUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUIVALENT
720149	UZ715	
720396	1N1814A	1N1814A
725019	1N765-1	1N765-1
725047	MR1211-5B	
725052	1N970B	1N970B
725076	1N3616	1N3616
725081	SCR216-2	
725082	SCR216-3	
725083	SCR216-5	
725085	SCR216-6	
725130	2N3670	2N3670
740001	MC790P	
740002	MC724P	
740004	709	
740005	MC1433P	
740020	740020	

MANUFACTURER'S CODE LISTING - ELECTRICAL PARTS

1) The numbers designated in the SPARES column of the following ELECTRICAL PARTS LISTING indicate the recommended spare parts requirement for support of this equipment for a period of one year.
2) Components that have Trygon listed in the column marked "MFR" are not necessarily manufactured by Trygon. However, these components are made in accordance with a Trygon specification control drawing. The best identification is Trygon's stock number.
3) Trygon reserves the right to substitute an equivalent part when the particular source has changed or the listed part is no longer availabe.
4) The code designations listed in the MFR column of the ELECTRICAL PARTS LISTING have been assigned to the manufacturers listed below:

CODE	MANUFACTURER	CODE	MANUFACTURER
A-B	ALLEN BRADLEY	MILW	MILWAUKEE
BUSS	BUSS	MOTO	MOTOROLA
CARL	CARLING	PHAO	PHAOSTRON
CORN	CORNISH	RCA	RADIO CORPORATION OF AMERICA
CTS	CHICAGO TELEPHONE SUPPLY	RO	ROGAN
ERIE	ERIE	ROT	ROTRON
GE	GENERAL ELECTRIC	SAGE	SAGE
GI	GENERAL INSTRUMENTS	SANG	SANGAMO
IEC	INTERNATIONAL ELECTRONICS CORP.	SPRA	SPRAGUE
IEH	INDUST. ELECT. HARDWARE	SUP	SUPERIOR
IRC	INTERNATIONAL RESISTOR CORP.	TRAN	TRANSITRON
HOFF	HOFFMAN	TRY	TRYGON
LEE	LEECRAFT	UNI	UNITRODE
MALL	MALLORY	WL	WARD LEONARD
MILL	MILLER	STACK	STACK POL

LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Recommend Spares	TRYGON STOCK =
C1, 101	Capacitor, 500 MFD, 75V	SPRA	39D507G075HL4	1	810223
C2,3,102,103	Capacitor, .0033 MFD, 600V	ERIE	CK62AW332M	1	800025
C4,5,104,105	Capacitor, .001 MFD, 600V	ERIE	CK62BX102M	1	800006
C6, 106	Capacitor, 850 MFD, 75V	SPRA	39D857G075HS4	1	810230
C7, 107	Capacitor, 1100 MFD, 50V	SPRA	39D118G050HP4	1	819945
C8, 108	Capacitor, 10 MFD, 50V	MALL	TTX010N050P1E	1	810010
C10, 110	Capacitor, 34 MFD, 15V	MALL	TTX034N015P1E	1	810057
C9, 109	Capacitor, .47 MFD, 250V	IEC	CM4700-2	1	800285
CR1,2,6,7,8,9, 10,11,12,13, 15,16,101,102, 106,107,108, 109,110,111, 112,113,115, 116	Diode	GI	IN4384	4	720384
CR3, 103	Diode, Zener	UNI	UZ824	1	720155
CR4, 104	Diode, Zener	MOTO	IN965A	1	720395
CR5, 105	Diode, Zener	MOTO	Z0132	1	720263
CR14, 114	Diode, Zener	TRAN	IN751A	1	720181
DS1	Pilot Light, Red Lens	LEE	36N1311-6	1	770024

LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Recommend Spares	TRYGON STOCK #
F1	Fuse	BUSS	MDX 3	5	870180
M1, 101	Meter, 40V/1A	TRY	753535	1	753535
P1	Cord, Line	CORN	18-3	1	941000
Q1,2,3,4,6,7,10 101,102,103,104 106,107,110	Transistor	GE	~~2N2716~~ 2N2714	4	700180
Q5, 105	Transistor TR1132	MOTO	2N1132	1	700000
Q8, 108	Transistor	TRY	705070	1	705070
Q9, 109	Transistor TR497	MOTO	2N4238	1	700047
R1, 101	Resistor, 420Ω, 5W, 5%	WL	5X420	1	640438
R2, 102	Resistor, 1.5KΩ, .5W, 1%	IRC	RN70D1501F	1	620360
R3, 103	Resistor, 402Ω, .5W, 1%	IRC	RN70D4020F	1	620140
R4,5,104,105	Resistor, 9.76KΩ, .5W, 1%	IRC	RN70D9761F	1	620599
R6, 106	Resistor, 680Ω, .5W, 10%	AB	RC20GF681K	1	610160
R7,37,107,137	Resistor, 2.49KΩ, .5W, 1%	IRC	RN70D2491F	1	620450
R8, 108	Resistor, 6.81KΩ, .5W, 1%	IRC	RN70D6811F	1	620596
R9, 109	Resistor, 475Ω, .5W, 1%	IRC	RN70D4750F	1	620160
R10, 110	Resistor, 6.19KΩ, .5W, 1%	IRC	RN70D6191F	1	620592
R11,27,28,29,111 127,128,129	Resistor, 1KΩ, .5W, 10%.	AB	RC20GF102K	2	610180

LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Recommend. Spares	TRYGON STOCK #
R12, 112	Resistor, 27KΩ, .5W, 10%	AB	RC20GF273K	1	610320
R13, 113	Resistor, 75KΩ, .5W, 1%	IRC	RN70D7502F	1	620754
R14, 114	Resistor, 12.7K, .5W, 1%	IRC	RN70D1272F	1	620621
R15, 115	Resistor, 6.34KΩ, .5W, 1%	IRC	RN70D6341F	1	620591
R16,17,116,117	Resistor, 6.65KΩ, .5W, 1%	IRC	RN70D6651F	1	620593
R18, 118	Resistor, 1.2KΩ, .5W, 10%	AB	RC20GF122K	1	610190
R19, 119	Resistor, 2.55KΩ, .5W, 1%	IRC	RN70D2551F	1	620462
R20,24,120,124	Potentiometer, 1.5KΩ, 1.5W, 10%	CTS	BE51113	2	600187
R21, 121	Resistor, 5.11K, .5W, 1%	IRC	RN70D5111F	1	620589
R22, 122	Resistor, 2KΩ, .5W, 1%	IRC	RN70D2001F	1	620432
R23, 123	Resistor, 500Ω, 3W, 3%	SAGE	1300S500-3	1	630340
R25, 125	Resistor, 3KΩ, 5W, 5%	WL	5X3000	1	640546
R26, 126	Resistor, 1KΩ, 3W, 3%	SAGE	1300S1000-3	1	630390
R30, 130	Resistor, 3.3KΩ, .5W, 10%	AB	RC20GF332K	1	610230
R31, 131	Resistor, 2.5KΩ, 10W, 5%	WL	10X2500	1	640543
R34, 134	Resistor, 374Ω, .5W, 1%	IRC	RN70D3740F	1	620135
R35, 135	Potentiometer, 500Ω, 1.5W, 10%	CTS	BK49791	1	600146
R36, 136	Resistor, 1Ω, 3W, 3%	SAGE	1300S1-3	1	630030
R38, 138	Resistor, 560Ω, 2W, 10%	AB	RC42GF561K	1	640480
R39, 139	Potentiometer, 150Ω, 1.5W, 20%	TRY	B2533	1	600070
R40, 140	Resistor-Shunt	TRY	DL40-1PD14044	1	PD14044
R41, 141	Resistor, 39.95KΩ, .5W, .5%	IRC	RN70D3992E	1	620700
R42,43,142,143	Potentiometer, 40K/100Ω, 2W DUAL	TRY	605140	1	605140
R44,45,144,145	Resistor, 12Ω, .5W, 5%	AB	RC20GF120J	1	610007

LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Recommend. Spares	TRYGON STOCK =
R48, 148	Resistor, 15Ω, .5W, 5%	AB	RC20GF150J	1	610009
R49,51,149,151	Resistor, 27Ω, .5W, 5%	AB	RC20GF270J	1	610016
R50, 150	Resistor, 24Ω, .5W, 5%	AB	RC20GF240J	1	610013
R46,47,146,147	Resistor, 10Ω, .5W, 1%	IRC	RN70D0100F	1	610006
S1	Switch, DPST	CARL	2BK63-73	1	
S2, 102	Switch, Rotary 2 Deck	STACK	304-70-4	1	880555
S3, 103	Switch, Slide	STACK	SS-50	1	
T1	Transformer	TRY	SDT40-1	1	509060
Mechanical - -	Recommended Spare Parts				
	Bumper, or Rubber Feet	HILL	BH2096W	2	840190
	Knob, Right	TRY	920061	1	920061
	Knob, Left	TRY	920062	1	920062
	Knob, Gray	RO	RB999-700-MOD	1	920071
	Knob, Black	RO	RB999-700	1	920111
	Binding Post, Back	SUP	DF21BC	1	920150
	Binding Post, Red	SUP	DF21RC	1	920160
	Binding Post, White	SUP	DF21WTC	1	920170
	Transistor Socket	IEH	LST1902-1	2	830101

TROUBLESHOOTING GUIDE

SECTION	COMPONENT	FUNCTION	DC VOLTAGE ±10%
Reference	CR3	Pre-Reg. Ref. Zener	24.0
	CR4	Reference Zener	15.0
	CR5	Reference Zener	9.4
	R10	Reference Offset	6.3
Comparator	Q6	Comparator	3.0
	Q7	Differential Ampl.	3.0
Series Reg.	CR14	Current Limit Ref.	5.1
	Q8	Series Pass	25.0
	Q9	Driver	35.0
	Q10	Driver	23.0
	R31	Output Bleed	65.0

NOTE:

All voltage measurements must be made when unit is operating at nominal AC input and rated DC output.

Base to emitter voltages of all transistors in the Series Regulator should be positive for conduction.

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